

## CLAIMS

What is claimed is:

1. A birdcage coil for use with a magnetic resonance (MR) system capable of acquiring images of a region of interest using parallel imaging techniques; the birdcage coil comprising:

5 (a) a first ring at an inferior end of the birdcage coil, said first ring being electrically conductive and having a first diameter through which the region of interest is provided access to the birdcage coil;

(b) a second ring at a superior end of the birdcage coil, said second ring being electrically conductive and having a second diameter smaller than said first diameter of said first  
10 ring; and

(c) a plurality of rods electrically interconnecting said first and said second rings to form the birdcage coil therewith, each of said rods having a linear portion and a tapered portion with said linear portion being connected to said first ring and said tapered portion being connected to said second ring, said tapered portions of said rods collectively providing the birdcage coil with a  
15 substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of the birdcage coil while at least one of maintaining and improving a signal-to-noise ratio of the birdcage coil;

wherein said rods and said first and said second rings are configured to form about the birdcage coil a plurality of partially-overlapped primary resonant substructures, with each of said  
20 primary resonant substructures including two of said rods and a corresponding section of each of said first and said second rings interconnecting them, which are capable of being used by said MR system for simultaneous reception of magnetic resonance signals from the region of interest.

2. The birdcage coil of claim 1 wherein said plurality of partially-overlapped primary resonant substructures are deployed generally symmetrically about the birdcage coil.

3. The birdcage coil of claim 1 wherein said plurality of partially-overlapped primary resonant substructures is three in number, with each being generally deployed 120 degrees apart.

4. The birdcage coil of claim 3 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

5. The birdcage coil of claim 1 wherein said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

6. The birdcage coil of claim 5 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

7. The birdcage coil of claim 1 wherein said plurality of partially-overlapped primary resonant substructures is six in number, with each being generally deployed 60 degrees apart.

8. The birdcage coil of claim 7 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

9. The birdcage coil of claim 1 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

10. The birdcage coil of claim 1 wherein:

(a) said plurality of rods is eight in number and selected ones of said rods are spaced at irregular distances from adjacent ones of said rods; and

5 (b) said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

11. The birdcage coil of claim 1 wherein the birdcage coil is a receive-only coil.

10 12. The birdcage coil of claim 1 wherein:

(a) each of said primary resonant substructures includes an active decoupling network in said corresponding section of said second ring thereof; and

(b) each of said rods includes a passive decoupling network therein.

15 13. The birdcage coil of claim 1 wherein each of said rods and said first and said second rings contain therein a plurality of reactive electrical components.

14. The birdcage coil of claim 1 wherein each of said primary resonant substructures includes a port connector in said corresponding section of said second ring thereof for connection to  
20 a channel of the MR system.

15. The birdcage coil of claim 1 wherein the birdcage coil is a transmit/receive coil.

16. The birdcage coil of claim 1 wherein the birdcage coil is configured as one of a low pass coil, a high pass coil and a band pass coil.

17. The birdcage coil of claim 1 wherein said first and said second rings are circular.

5

18. The birdcage coil of claim 1 wherein at least one of said first and said second rings are elliptical.

19. The birdcage coil of claim 1 further comprising at least one additional coil at least  
10 partially overlapping the birdcage coil at the inferior end thereof to extend the field of view.

20. The birdcage coil of claim 1 wherein said first ring and said second ring are each larger in diameter than a center of the birdcage coil.

15 21. The birdcage coil of claim 1 wherein said rods and said first and said second rings are supported and housed within a housing therefor.

22. A birdcage coil for use with a magnetic resonance (MR) system capable of acquiring images of a region of interest using parallel imaging techniques; the birdcage coil comprising:

20 (a) a first ring at one end of the birdcage coil, said first ring being electrically conductive and having a first diameter;

(b) a second ring at an other end of the birdcage coil, said second ring being electrically conductive and having a second diameter different from said first diameter of said first ring; and

(c) a plurality of rods electrically interconnecting said first and said second rings to form the birdcage coil therewith;

wherein said rods and said first and said second rings are configured to form about the birdcage coil a plurality of partially-overlapped primary resonant substructures, with each of said primary resonant substructures including two of said rods and a corresponding section of each of said first and said second rings interconnecting them, which are capable of being used by said MR system for simultaneous reception of magnetic resonance signals from the region of interest.

23. The birdcage coil of claim 22 wherein each of said rods has a linear portion and a tapered portion with said linear portion being connected to said first ring and said tapered portion being connected to said second ring, said tapered portions of said rods collectively providing said coil with a substantially homogeneous pattern of magnetic flux density in at least one of three orthogonal imaging planes of said coil.

24. The birdcage coil of claim 23 wherein said tapered portion of each of said rods comprises at least one angled linear segmented section.

25. The birdcage coil of claim 22 wherein said second diameter of said second ring is smaller than said first diameter of said first ring.

26. The birdcage coil of claim 22 wherein said first and said second rings are circular.

27. The birdcage coil of claim 22 wherein at least one of said first and said second rings are elliptical.

28. The birdcage coil of claim 22 wherein said plurality of partially-overlapped primary resonant substructures are deployed generally symmetrically about the birdcage coil.

5 29. The birdcage coil of claim 22 wherein said plurality of partially-overlapped primary resonant substructures is three in number, with each being generally deployed 120 degrees apart.

30. The birdcage coil of claim 29 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

10

31. The birdcage coil of claim 22 wherein said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

32. The birdcage coil of claim 31 wherein selected ones of said rods are spaced at  
15 irregular distances from adjacent ones of said rods.

33. The birdcage coil of claim 22 wherein said plurality of partially-overlapped primary resonant substructures is six in number, with each being generally deployed 60 degrees apart.

20 34. The birdcage coil of claim 33 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

35. The birdcage coil of claim 22 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

36. The birdcage coil of claim 22 wherein:

5 (a) said plurality of rods is eight in number and selected ones of said rods are spaced at irregular distances from adjacent ones of said rods; and

(b) said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

10 37. The birdcage coil of claim 22 wherein the birdcage coil is a receive-only coil.

38. The birdcage coil of claim 22 wherein:

(a) each of said primary resonant substructures includes an active decoupling network in said corresponding section of said second ring thereof; and

15 (b) each of said rods includes a passive decoupling network therein.

39. The birdcage coil of claim 22 wherein each of said rods and said first and said second rings contain therein a plurality of reactive electrical components.

20 40. The birdcage coil of claim 22 wherein each of said primary resonant substructures includes a port connector in said corresponding section of said second ring thereof for connection to a channel of the MR system.

41. The birdcage coil of claim 22 wherein the birdcage coil is a transmit/receive coil.

42. The birdcage coil of claim 22 wherein the birdcage coil is configured as one of a low pass coil, a high pass coil and a band pass coil.

5

43. The birdcage coil of claim 22 further comprising at least one additional coil at least partially overlapping the birdcage coil at an inferior end thereof to extend the field of view.

44. The birdcage coil of claim 22 wherein said first ring and said second ring are each  
10 larger in diameter than a center of the birdcage coil.

45. The birdcage coil of claim 22 wherein said first ring and said second ring are each smaller in diameter than a center of the birdcage coil.

46. The birdcage coil of claim 22 wherein said rods and said first and said second rings  
15 are supported and housed within a housing therefor.

47. A birdcage coil for use with a magnetic resonance (MR) system capable of acquiring images of a region of interest using parallel imaging techniques; the birdcage coil comprising:

20 (a) a first ring at one end of the birdcage coil, said first ring being electrically conductive and having a first diameter;

(b) a second ring at an other end of the birdcage coil, said second ring being electrically conductive and having a second diameter; and



(c) a plurality of rods electrically interconnecting said first and said second rings to form the birdcage coil therewith;

wherein said rods and said first and said second rings are configured to form about the birdcage coil a plurality of partially-overlapped primary resonant substructures, with each of said primary resonant substructures including two of said rods and a corresponding section of each of said first and said second rings interconnecting them, which are capable of being used by said MR system for simultaneous reception of magnetic resonance signals from the region of interest.

48. The birdcage coil of claim 47 wherein said second diameter of said second ring is smaller than said first diameter of said first ring.

49. The birdcage coil of claim 48 wherein each of said rods has a linear portion and a tapered portion with said linear portion being connected to said first ring and said tapered portion being connected to said second ring.

50. The birdcage coil of claim 49 wherein said tapered portion of each of said rods comprises at least one angled linear segmented section.

51. The birdcage coil of claim 47 wherein said first and said second diameters of said first and said second rings, respectively, are equal.

52. The birdcage coil of claim 47 wherein said first and said second rings are circular.

53. The birdcage coil of claim 47 wherein at least one of said first and said second rings are elliptical.

54. The birdcage coil of claim 47 wherein said plurality of partially-overlapped primary resonant substructures are deployed generally symmetrically about the birdcage coil.

55. The birdcage coil of claim 47 wherein said plurality of partially-overlapped primary resonant substructures is three in number, with each being generally deployed 120 degrees apart.

56. The birdcage coil of claim 55 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

57. The birdcage coil of claim 47 wherein said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

58. The birdcage coil of claim 57 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

59. The birdcage coil of claim 47 wherein said plurality of partially-overlapped primary resonant substructures is six in number, with each being generally deployed 60 degrees apart.

60. The birdcage coil of claim 59 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

61. The birdcage coil of claim 47 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

5 62. The birdcage coil of claim 47 wherein:

(a) said plurality of rods is eight in number and selected ones of said rods are spaced at irregular distances from adjacent ones of said rods; and

(b) said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

10 63. The birdcage coil of claim 47 wherein the birdcage coil is a receive-only coil.

64. The birdcage coil of claim 47 wherein:

(a) each of said primary resonant substructures includes an active decoupling network in  
15 said corresponding section of said second ring thereof; and

(b) each of said rods includes a passive decoupling network therein.

65. The birdcage coil of claim 47 wherein each of said rods and said first and said second rings contain therein a plurality of reactive electrical components.

20 66. The birdcage coil of claim 47 wherein each of said primary resonant substructures includes a port connector in said corresponding section of said second ring thereof for connection to a channel of the MR system.

67. The birdcage coil of claim 47 wherein the birdcage coil is a transmit/receive coil.

68. The birdcage coil of claim 47 wherein the birdcage coil is configured as one of a low  
5 pass coil, a high pass coil and a band pass coil.

69. The birdcage coil of claim 47 further comprising at least one additional coil at least  
partially overlapping the birdcage coil at an inferior end thereof to extend the field of view.

10 70. The birdcage coil of claim 47 wherein said first ring and said second ring are each  
larger in diameter than a center of the birdcage coil.

71. The birdcage coil of claim 47 wherein said first ring and said second ring are each  
smaller in diameter than a center of the birdcage coil.

15 72. The birdcage coil of claim 47 wherein said rods and said first and said second rings  
are supported and housed within a housing therefor.

73. A birdcage coil for use with a magnetic resonance (MR) system; the birdcage coil  
20 comprising:

(a) a first ring at one end of the birdcage coil, said first ring being electrically  
conductive and having a first diameter;

(b) a second ring at an other end of the birdcage coil, said second ring being electrically conductive and having a second diameter; and

(c) a plurality of rods electrically interconnecting said first and said second rings to form the birdcage coil therewith;

5 wherein said rods and said first and said second rings are configured to form about the birdcage coil a plurality of partially-overlapped primary resonant substructures, with each of said primary resonant substructures including two of said rods and a corresponding section of each of said first and said second rings interconnecting them.

10 74. The birdcage coil of claim 73 wherein said second diameter of said second ring is smaller than said first diameter of said first ring.

15 75. The birdcage coil of claim 74 wherein each of said rods has a linear portion and a tapered portion with said linear portion being connected to said first ring and said tapered portion being connected to said second ring.

76. The birdcage coil of claim 75 wherein said tapered portion of each of said rods comprises at least one angled linear segmented section.

20 77. The birdcage coil of claim 73 wherein said first and said second diameters of said first and said second rings, respectively, are equal.

78. The birdcage coil of claim 73 wherein said first and said second rings are circular.

79. The birdcage coil of claim 73 wherein at least one of said first and said second rings are elliptical.

80. The birdcage coil of claim 73 wherein said plurality of partially-overlapped primary resonant substructures are deployed generally symmetrically about the birdcage coil.

81. The birdcage coil of claim 73 wherein said plurality of partially-overlapped primary resonant substructures is three in number, with each being generally deployed 120 degrees apart.

82. The birdcage coil of claim 81 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

83. The birdcage coil of claim 73 wherein said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

84. The birdcage coil of claim 83 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

85. The birdcage coil of claim 73 wherein said plurality of partially-overlapped primary resonant substructures is six in number, with each being generally deployed 60 degrees apart.

86. The birdcage coil of claim 85 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

87. The birdcage coil of claim 73 wherein selected ones of said rods are spaced at irregular distances from adjacent ones of said rods.

5 88. The birdcage coil of claim 73 wherein:

(a) said plurality of rods is eight in number and selected ones of said rods are spaced at irregular distances from adjacent ones of said rods; and

(b) said plurality of partially-overlapped primary resonant substructures is four in number, with each being generally deployed 90 degrees apart.

10 89. The birdcage coil of claim 73 wherein the birdcage coil is a receive-only coil.

90. The birdcage coil of claim 73 wherein:

(a) each of said primary resonant substructures includes an active decoupling network in  
15 said corresponding section of said second ring thereof; and

(b) each of said rods includes a passive decoupling network therein.

91. The birdcage coil of claim 73 wherein each of said rods and said first and said second rings contain therein a plurality of reactive electrical components.

20 92. The birdcage coil of claim 73 wherein each of said primary resonant substructures includes a port connector in said corresponding section of said second ring thereof for connection to a channel of the MR system.

93. The birdcage coil of claim 73 wherein the birdcage coil is a transmit/receive coil.

94. The birdcage coil of claim 73 wherein the birdcage coil is configured as one of a low  
5 pass coil, a high pass coil and a band pass coil.

95. The birdcage coil of claim 73 further comprising at least one additional coil at least  
partially overlapping the birdcage coil at an inferior end thereof to extend the field of view.

10 96. The birdcage coil of claim 73 wherein said first ring and said second ring are each  
larger in diameter than a center of the birdcage coil.

97. The birdcage coil of claim 73 wherein said first ring and said second ring are each  
smaller in diameter than a center of the birdcage coil.

15 98. The birdcage coil of claim 73 wherein said rods and said first and said second rings  
are supported and housed within a housing therefor.